

Research by Federal Agencies on Dairy Manufacturing

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Research on the manufacture of dairy products as a function of the United States Government was first undertaken only a few years prior to the birth of the American Dairy Science Association, the first research bulletin having been published by the Bureau of Animal



E. O. Whittier

Industry in 1903. The Dairy Division had been established in the Bureau of Animal Industry on July 1, 1895, and authorized by the Congress "to collect and disseminate information relating to the dairy industry of the United States." That was precisely and exclusively what it did until 1902, when L. A. Rogers became an employee of the Division. There was an "expert in dairy chemistry," G. E. Patrick, working in the Bureau of Chemistry at that time on routine analyses for Henry E. Alvord, chief of the Dairy Division of the Bureau of Animal Industry; this work was being done in connection with efforts of R. E. Pearson, assistant chief of the Division, to make a sterile butter for shipment to England. But except for this work, which was unfruitful, research in the Dairy Division began with Dr. Rogers, whose first publication was on "Canned Butter" and was dated 1904.

The Dairy Division was not permitted for several years to have laboratories of its own in Washington; such research as was done in Washington was in the laboratories of the Biochemic Division. Therefore, when E. H. Webster became chief of the Division in 1904, he was able to carry out his ideas for developing dairy products only by placing men at state experiment stations, where they worked in cooperation with members of the staffs of the stations and often under their supervision. Later, during the period 1909-1920 when B. H. Rawl was chief of the Division, these cooperative arrangements were terminated and the research activities were gradually transferred to Washington.

Cooperative Research Started

The earliest cooperative research was at Madison, Wis., and Geneva, N. Y., where work was conducted on Cheddar cheese; the first bulletin was entitled "The Cold Curing of Cheese," and bore the names of S. M. Babcock and H. L. Russell of the Wisconsin Experiment Station and L. L. Van Slyke, G. A. Smith, and E. B.

Hart of the New York Experiment Station. The participation of the Dairy Division in the work on which this bulletin was based seems to have been only financial, but later on personnel were assigned to the Wisconsin Station. It was there in 1913 that J. L. Sammis and A. T. Bruhn showed the desirability of making Cheddar cheese from pasteurized milk, a practice that did not come into general use until 30 years later after H. L. Wilson had shown that a slow development of acidity in the cheese vat was needed and could be obtained through proper control of the starter used.

L. A. Rogers and C. E. Gray were assigned in 1903 to the Iowa State Experiment Station at Ames to do research on butter. They spent a winter there while work was being done to provide laboratories and equipment. By spring, the farmers who previously had supplied milk for research at the Station had found other outlets for their milk. So, having to seek facilities elsewhere, Rogers and Gray went to Madison, where they begged the use of the University creamery to make one batch of experimental butter. They then proceeded to Bloomer, Wis., where they set up a laboratory in a tent and carried on their research in conjunction with a cooperative creamery. After a summer at Bloomer and a few months of work at Albert Lea, Minn., they set up a laboratory in the kitchen and woodshed of an old house in Washington near the area now occupied by buildings of the Department of Agriculture and there completed their researches on butter. This was the first dairy products research laboratory in Washington.



FIG. 1. Judging milk at the National Dairy Show in Chicago, 1906. Left to right, L. A. Rogers, W. A. Stocking, C. B. Lane, Ivan C. Weld, C. E. Gray.

The work of Rogers and Gray established the facts that the keeping quality of butter made from pasteurized cream is inversely proportional to the acidity of the cream and that butter can be made from sweet cream. These facts were verified on a large scale in butter made for the United States Navy under the

supervision of the Dairy Division. The general application of these findings resulted in almost complete elimination of fishy, oily, and metallic flavors, which previously had appeared in almost all butter held in storage for appreciable time.

At the Missouri Experiment Station at Columbia, the Dairy Division placed R. H. Shaw with several assistants to work in cooperation with C. H. Eckles on the composition and properties of milk. The publications resulting from this work began to appear in 1911. L. S. Palmer began his work at Columbia under the auspices of the Dairy Division, his first publication on the pigments of milk appearing in 1914.

H. W. Conn of the Connecticut Experiment Station at Storrs proposed about 1902 that he be sent by the Department of Agriculture to France to study Roquefort cheese. Major Alvord did not support this proposition, since he was already planning to do research on Roquefort. Whereupon, Congressional pressure was exerted on Secretary of Agriculture Wilson, who decreed that he would not send anyone to France but would finance cooperative research on the mold-ripened cheeses at Storrs. Three men with salaries paid by the Department were placed at that station. Charles Thom was the mycologist of the group from the Dairy Division, A. W. Dox was the chemist, and K. J. Matheson the cheese technologist. Thom's "Fungi in Cheese Ripening" in 1906 and his classic description of the penicillia in 1909 were important publications resulting from the work at Storrs. Dox was succeeded by J. M. Currie, whose research on the production of citric acid from sugars by the aspergilli was the basis for the commercial development of the mycological production of this acid.

About 1905 an arrangement was made with a cooperative creamery at Albert Lea, Minn., for experimental work on butter and cheese. Although Rogers and Gray made some butter at Albert Lea, most of the research activity there was by C. F. Doane on Swiss cheese. After about 3 years, this cheese research was transferred to Troy, Pa., where it was conducted in connection with a privately owned creamery. The work was terminated prior to 1915, when the creamery was converted into a condensery. Doane was the first to show that a lactobacillus is essential in the making of Swiss cheese and that the use of dry rennet soaked in whey was necessary only because it provided the essential bacteria. As a result of this and related later work, Swiss cheese factories came to use rennet extract and pure cultures. In 1908 Doane published Bulletin 105, "Varieties of Cheese," a publication that has gone through many revisions and is still one of the most popular Government publications relating to dairy products.

About 1915 the business men of Grove City, Pa., were induced to form a stock company to

build a creamery according to plans drawn by K. E. Parks of the Dairy Division. This was operated by the Dairy Division as a market milk and milk products plant, making butter, cheese and evaporated milk, and, at times, casein and lactose. Bacteriologists and a chemist were stationed there and did research in a laboratory in the plant. They also participated in semi-plant development of improved manufacturing procedures and new products. The research of G. A. Ramsdell on resazurin as an indicator of the sanitary quality of milk and the work of S. A. Hall on Roquefort cheese were done at Grove City. Soon after 1930, research activities were abandoned at Grove City and similar work was undertaken at the Agricultural Research Center at Beltsville, Md. Thus ended sponsorship by the Department of Agriculture of research in dairy manufactures outside of the Washington area, until it was resumed about 20 years later.

Research Laboratories Established in Washington

The ban on laboratories in Washington for dairy products research had been lifted when B. H. Rawl became chief of the Dairy Division in 1909, and several rooms on the fourth floor of the newly built east wing of the Department of Agriculture building were assigned to the Dairy Research Laboratories of the Dairy Division. These laboratories were under the direction of L. A. Rogers, who, at least in some of his publications at that time, had the title of bacteriological chemist. As cooperative research at the state experiment stations was gradually discontinued, the government-paid workers were transferred to Washington—K. J. Matheson



FIG. 2. L. A. Rogers led the early research work in the Bureau of Dairy Industry and was chief of the Division of Dairy Research Laboratories from 1921 to 1942.

from Storrs, Alice Evans from Madison, and R. H. Shaw and P. A. Wright from Columbia. Other research workers were recruited until nearly the whole fourth floor of the east wing was occupied by personnel working on problems relating to cheese, butter, evaporated and condensed milk, dried milk, ice cream, casein, and lactose. About 1912, research was initiated on the physiology and nutrition of dairy cows. This was under the immediate direction of E. B. Meigs at the Agricultural Research Center, at Beltsville. Since this work is closely related to production rather than to manufacture, its history is not discussed here.

Important accomplishments between 1909 and 1921 include: the finding by H. F. Zoller and O. E. Williams that the sandiness sometimes developing in ice cream is attributable to crystals of lactose; the extensive researches of S. H. Ayers and W. T. Johnson, Jr., on the bacteriology of pasteurized milk, particularly the identification of the bacteria that survive pasteurization; the establishing by J. M. Sherman that the characteristic flavor of Swiss cheese and the "eyes" are the result of the metabolic activities of propionic-acid-producing bacteria; and the researches of W. M. Clark and H. A. Lubs relating to hydrogen-ion concentration. A series of sulfonephthalein indicators for colorimetric determination of hydrogen-ion concentration was synthesized by Lubs. Clark's work on the hydrogen electrode, the hydrogen-ion potential of buffers, and the effects of hydrogen-ion concentration on the multiplication of bacteria, is well known. It is not so well known that he established the conditions for the coagulation and processing of grain-curd casein.

In 1921, C. W. Larson became chief of the Dairy Division, and, in 1924, when the Division became a Bureau, he became the first chief of the Bureau of Dairy Industry. Concurrently, the Dairy Research Laboratories became a Division with Dr. Rogers as its chief. O. E. Reed succeeded C. W. Larson as chief of Bureau in 1928 and continued in the office until the dissolution of the Bureau in 1954. Dr. Rogers retired in 1942 after 40 years of activity in doing and directing the Department's dairy products research.

In the period from 1921 to 1942 was done most of the work of G. E. Holm and G. R. Greenbank on the oxidative deterioration of fats and on conditions for retarding the deterioration of butterfat in dried whole milk. B. H. Webb, R. W. Bell, and coworkers investigated extensively the effects of heat and other processing factors on the viscosity and stability of evaporated milk. Alan Leighton worked on the physical chemistry of ice cream, with special emphasis on its viscosity. He discovered that the addition of cane sugar to skimmilk before concentration caused the concentrated milk to have a low viscosity and permitted the easy separation of lactose crystals. This made pos-

sible the production of a low-lactose concentrated or dried skimmilk whereby the proportion of nonfat milk solids in ice cream can be increased without danger of development of sandiness. In the same period L. A. Rogers investigated the factors controlling and limiting bacterial populations; as a by-product of this work, there was developed a commercial process for producing lactic acid by fermentation of whey. W. C. Frazier investigated the proteolytic bacteria of milk and, with E. O. Whittier, the oxidation-reduction potential of cultures of bacteria found in milk. A search for means of killing bacterial spores without the use of a degree of heat producing objectionable color and flavors in milk was begun by H. R. Curran and F. R. Evans in 1930 and is still continuing. Mr. Whittier worked on the ionic equilibria and buffer intensities in milk, with Anne G. Benton on the effects of heat on the H-ion concentration of milk, and with R. W. Bell and S. P. Gould on improvements in the manufacture of commercial casein and on the production of casein fiber. In 1928 the staff of the Dairy Research Laboratories produced the first edition of *Fundamentals of Dairy Science*, and in 1935, a second edition.

In 1939, research on nonfood dairy products was transferred to the regional laboratory in Philadelphia now designated as the Eastern Utilization Research Branch, work on lactic acid derivatives and on casein fiber being continued there. Later, fundamental research on the proteins of milk was undertaken by T. L. McMeekin and his associates, their work on the components of casein and on the individual whey proteins being well known. The recent work of S. R. Hoover and coworkers on the disposal of dairy wastes by biochemical oxidation was done at that laboratory.

G. E. Holm became head of the Dairy Products Research Division of the Bureau of Dairy Industry in 1942 and he continued as head until 1955. Some of the more important research accomplishments of this period were those of T. F. Ford and associates on the deter-

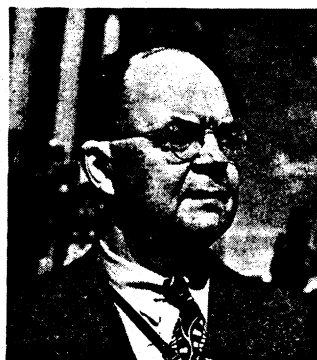


FIG. 3. G. E. Holm (deceased) was head of the Dairy Products Research Division of the Bureau of Dairy Industry from 1942 to 1955.

mination of the particle sizes of the casein-containing colloid of milk and the effects of heat and other factors on the size distribution; the production of a resinous protective coating from lactic acid and the development of a practical lactometer of a high degree of accuracy by P. D. Watson; the production of vitamin B₁₂ by means of the propionic fermentation by A. Leviton, the application to cheese of the phosphatase test for efficiency of pasteurization by G. P. Sanders and O. S. Sager; the development of a detergent method for determining fat in dairy products by O. S. Sager; and the development by H. E. Walter and associates of a procedure for making Cheddar cheese in half the customary time.

Research Work Now in Eastern Utilization Research Branch

In February, 1955, the dairy products research activities that began in the Bureau of Animal Industry and continued in the Bureau of Dairy Industry became, after a year of transition in the Washington Utilization Research Branch, a part of the Eastern Utilization Research Branch of the Agricultural Research Service. Thus, all research on manufactured dairy products in the Department of Agriculture was again under one chief, P. A. Wells. The dairy research of the present and immediate future in this organization is concerned with lessening the cost of manufacturing dairy products and with improving their quality. New products from milk that will satisfy new needs and thus increase the utilization of milk are being sought. Research is under way on

cheese of several varieties, on butter, and on frozen, concentrated, and dried milks. Special effort is being made to perfect a form of concentrated or dried milk that, even after a year or more in storage, can be readily reconstituted to give a fluid milk having the flavor, consistency, and other characteristics of fresh milk. To supply a sound basis for this work, fundamental research is being done on the desirable and undesirable chemical and physical changes that occur in the processing of dairy products, as in heating, concentrating, drying, storing, and bacterial fermentations.

Again, as in the earlier years, some research on dairy products is being sponsored in state experiment stations, now, however, by research contracts instead of by the informal cooperative arrangements of 40 years ago. Research on Italian-type cheese is being sponsored at the Ohio Station, research on Swiss cheese at the Wisconsin Station, and research on the relationship of salt equilibria in heated milk to its physical stability at the Minnesota Station.

The easy problems in dairy manufacturing have been for the most part solved. This has been accomplished largely in the past 50 years in laboratories in Europe, Canada, the United States, and Australia. The difficult problems remain to challenge us. But with more extensively and intensively trained researchers, with the constantly appearing new research tools and techniques, and with continuing cooperation among federal, university and industrial research laboratories, it can be expected that dairy products research in the United States will in the future, as in the past, make important contributions to the prosperity of the nation and the well-being of its people.